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Complete Specification entitled (54) ABSORBENT PRODUCTS AND METHODS OF MAKING THE SAME

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The following statement is a full description of this invention, including the best method of performing it known to us

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The present invention relates to absorbent products for absorbing and retaining body fluids, blood, and other body exudates. More particularly, the present invention relates to absorbent products, such as surgical sponges and pads and more specifically laparotomy sponges and pads, having excellent softness and excellent strength, bulk, resilience, and resistance to surface abrasion and linting, particularly when wet. The present invention also relates to methods of making such absorbent products.

The present invention will be described with particular reference to absorbent products such as surgical sponges and pads, and more specifically laparotomy sponges and pads, but it is to be appreciated that the broader aspects and principles of the present invention are equally applicable to other absorbent products wherein the properties of softness, strength, bulk, resilience, and resistance to surface abrasion and linting, particularly when wet, are of interest. Such other absorbent products include, for example, general use sponges and pads, diapers, surgical dressings, post-operative dressings, underpads, combine pads, compresses, and the like.

A laparotomy is a medical or surgical procedure or operation involving an incision through any part of the abdominal wall into the abdominal cavity. During such a medical procedure, and in many other medical procedures and operations, such as open heart, thoracic, GYN, etc., laparotomy sponges are used to absorb relatively large amounts of body fluids, blood, and other body exudates.

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Such laparotomy sponges are also used to wall off organs, cover the outer edges of the incision, handle organs, pack off areas in the incision opening so that it is easier to gain access to other organs in the cavity opening, etc.

At the present time, sponges made of cotton gauze are customarily used to carry out such functions. Such cotton gauze sponges are usually made from 4 plies of U.S.P. 28 x 24 mesh cotton gauze and usually come in sizes of 12 inches x 12 inches square, 18 inches x 18 inches square, 18 inches x 4 inches oblong, 36 inches x 8 inches oblong, etc.

Such cotton gauze sponges, however, are subject to many disadvantages. For example, they have a relatively high initial cost and have relatively high subsequent labor costs due to their re-usable nature requiring laundering and sterilization after each use, hand removal of pills or neps from the surface to prevent them from falling off during an operation, repairing, resewing, hand-folding, etc. Also, the danger of infection and cross-contamination is a very serious consideration.

Additionally, the used sponges, even though thoroughly washed and sterilized, are usually spotted with blood or other stains from previous medical or surgical procedures or operations and thereby present a very unsightly and somewhat repulsive appearance. The esthetic and pyschological effect of such a stained or spotted sponge is not very pleasing.

It is therefore very desirable that an economical,

single-use, disposable sponge or pad be developed and used to avoid the above-mentioned disadvantages. It is also very necessary that such a sponge or pad be soft and that it possess excellent strength, bulk, resilience, and resistance to surface abrasion and linting, particularly when wet.

It has been discovered that such a single-use, disposable sponge or pad may be made by forming a synthetic polymeric thermoplastic reinforcing grid netting defining a pattern of open areas, placing at least one layer of absorbent fibrous materials on each side of the grid netting, adhering the layer of fibrous materials to the grid netting, then forming a laminate of a plurality of layers of such grid netting and fibrous materials adhered thereto, and securing the plurality of layers together at their peripheral edges, and internally of such edges, if so desired.

The inventive concept will be described in greater specificity by reference to the accompanying drawings and following specification wherein there is illustrated and described perferred apparatus and methods for producing the novel products of the present invention. It must be understood, however, that the inventive concept is not to be considered limited to the constructions shown except as determined by the scope of the appended claims.

In the drawings:

Figure 1 is a simplified, schematic, perspective, exploded view of a reinforced nonwoven textile fabric

composed of a plurality of fibrous webs and a centrally located reinforcing reticulate grid netting, prior to assembling and processing in accordance with the principles of the present invention;

Figure 2 is a fragmentary, perspective view of a preferred embodiment of the reinforcing reticulate grid netting of Figure 1;

Figure 3 is a simplified, schematic drawing of a preferred embodiment of apparatus and a method suitable for utilizing the principles of the present invention for making the reinforced nonwoven textile fabric such as shown in Figure 1;

Figure 4 is a simplified, schematic drawing of a preferred embodiment of apparatus and a method suitable for utilizing the principles of the present invention for assembling a plurality of reinforced nonwoven textile fabrics such as shown in Figure 1;

Figure 5 is a simplified, schematic drawing of another preferred embodiment of apparatus and a method for utilizing the principles of the present invention for assembling a plurality of reinforced nonwoven textile fabrics such as shown in Figure 1;

Figure 6 is a simplified plan view of a laparotomy sponge as prepared by utilizing the principles of the present invention;

Figure 7 is a partially exploded, magnified cross-sectional view of the laparotomy sponge of Figure 6, taken on the line 7-7 thereof, in the direction indicated by

the arrows.

Figure 8 is a simplified plan view of another laparotomy sponge as prepared by utilizing the principles of the present invention;

Figure 9 is a partially exploded, magnified, cross-sectional view of the laparotomy sponge of Figure 8, taken on the line 9-9 thereof, in the direction indicated by the arrows.

With reference to the drawings and with particular reference to Figure 1 thereof, there is shown a reinforced nonwoven textile fabric 10 comprising an outer layer 12 of fibrous material, a centrally or internally disposed reinforcing reticulate plastic grid netting 14, and another outer layer 18 of fibrous material.

THE FIBROUS LAYER

Each outer layer 12 and 18 may comprise merely a single fibrous web or may comprise a number of laminated fibrous webs which are brought together, usually to create a heavier weight layer.

The fibers which are employed to make up the layers 12 and 18 are highly absorbent and are preferably of a cellulosic nature, such as cotton or rayon. However, other fibers, either synthetic, man-made, or natural, may be used in various proportions for special purposes or for special effects. Illustrative of such other fibers are the polyamides (nylon 6/6, nylon 6, nylon 610, nylon 11, etc.), acrylic fibers (Acrilan, Creslan, Orlon, etc.), modacrylic fibers (Dynel, Verel, etc.), polyester fibers

(Dacron, Kodel, etc.), polyolefinic fibers (polyethylene, polypropylene, etc.), cellulose ester fibers (cellulose acetate, cellulose triacetate, etc.).

It is not essential that the fibrous layers 12, 18 placed on each side of the plastic grid netting 14 be composed of the same type of fiber or the same denier or even that one layer be made of only one type of fiber or that both layers have the same weight. Blends and mixtures of the above-referred to fibers are, of course, possible in substantially any range of proportions or weights, as desired or required.

It is preferred that the fibers be of textile staple length or equivalent length, or at least be cardable, that is to say, they should be from about ½ inch in average length up to about 3 inches or more in average length. Shorter fibers, down to about 3/16 inch or less in average length may be added in various proportions to comprise up to about 50% by weight of the web, or may comprise the entire web, particularly where the original method of web formation involved a fluid deposition of fibers, such as in a conventional or modified aqueous papermaking process, or in air deposition techniques. In such fluid deposition processes, average fiber lengths of about 3/16 inch or 1/8 inch are preferred to the extremely short fiber lengths of down to about 1/16 or 1/32 inch and even below, such as used in conventional papermaking processes for making paper. Such very short fibers, such as these found in conventional papermaking processing, are of use, however, particularly

for economic reasons or in those uses and applications wherein the tendencies toward paper-lik properties and characteristics of paper and paper products are not objectionable.

The denier of the synthetic or man-made fibers used in forming the fibrous webs is preferably in the range of the approximate thickness of the natural fibers mentioned and consequently deniers in the range of from about 1 to about 3 are preferred. However, where greater opacity or greater covering power is desired, deniers of down to about 3/4 or even about 1/2 may be employed. Where desired, deniers of up to 10, 15 or higher, may be used. The minimum and maximum denier are, of course, dictated by the desires or requirements for producing a particular fibrous web or nonwoven fabric, and by the machines and methods for producing the same.

The weight of the individual fibrous layer which is placed on each side of the reinforcing reticulate grid netting may be varied within relatively wide limits, depending upon the requirements of the finished product. A single, thin web of fibers, such as produced by a card, may have a weight of from about 40 to about 200 grains per square yard. The minimum weight of one individual fibrous layer contemplated by the present invention is, however, about 100 grains per square yard, usually obtained from one card or by plying two card webs. The maximum weight for one individual fibrous layer may range upwards to about 600 or more grains per square yard

depending upon the intended use of the final product. Within the more commercial aspects of the present invention, however, individual fibrous layer weights of from about 120 grains per square yard to about 300 grains per square yard are contemplated.

These weights are measured prior to any shrinking of the fabric during subsequent processing and will increase accordingly subsequent to such shrinking.

The number of fibrous layers in the reinforced nonwoven fabric should, of course, be at least two, that is, one layer on each side of the plastic grid netting, in order to obtain the desired or required effects. Three, four, five or more layers, in any desired arrangement may be used with the plastic grid netting in the center or closer to one surface, as desired, where special effects are desired.

It is possible that a particular bonded reinforced nonwoven fabric may comprise more than one reinforcing reticulate plastic grid netting. For example, the reinforced nonwoven fabric may comprise three layers of fibrous webs as the two outermost layers and a central layer, with the two plastic grid netting sandwiched in alternating fashion between the three layers of fibrous webs. Other arrangements and other configurations involving a plurality of plastic grid nettings and a plurality of fibrous webs are also possible depending upon the needs and requirements of the particular situation.

Also, if carded or fiber oriented webs are used as

the fibrous webs, it is not essential that the predominant direction of fiber orientation be the same for all the card webs. If desired, the card webs may be cross-laid with their predominant direction of fiber orientation at right angles or other angles to each other, whereby various strength relationships are available.

It is, of course, possible to apply a fibrous layer to merely one side of the plastic grid netting and such would yield a fabric with different properties, characteristics, and appearance on each side. Such a fabric is of use where such differences can be tolerated.

THE GRID NETTING

The reticulate grid netting 14 which is positioned between the fibrous layers 12 and 18 is a thermoplastic synthetic polymeric material, such as polypropylene, polyethylene (low density 0.91-0.94, medium density 0.94, and high density 0.95-0.96 and above); polyamides especially nylon 66 (hexamethylene diamine-adipic acid); nylon 610 (hexamethylene diamine-sebacic acid) and nylon 6 (polycaprolactam); polyesters especially polyethylene glycol terephtholate; polyacrylics or modacrylics; etc. These and other materials are of use provided they possess the necessary thermoplastic properties and other chemical and physical characteristics to the required degree and are capable of thermal or other activation as described herein.

High density polyethylene having a density generally greater than 0.94 grams per cubic centimeter, as well as predominantly isotactic polypropylene are of exceptional

applicability to the principles of the present inventive concept.

As shown in Figure 2, the reticulate grid netting 14 comprises intersecting rods or monofilaments 15 running in one direction and rods or monofilaments 15a running cross-wise to the rods or monofilaments 15. The intersecting rods or monofilaments 15 and 15a are preferably basically integral at their intersections 16 and define a regular pattern comprising a plurality of rectangular open areas 17 therebetween. Methods and apparatus for making such reticulate grid nettings are disclosed in greater detail in Australian Patent No. 444,339. ~~copending, commonly assigned patent applications Serial No. 736,356, filed July 12, 1968; Serial No. 799,438, filed February 14, 1969; Serial No. 857,989, filed September, 15 1969.~~

The open areas 17 are preferably rectangular or square, as shown, but it is to be appreciated that other geometric shapes may be used. Such other shapes include diamonds, parallelograms, rhomboids, polygons, etc., and are created by having the rods or monofilaments 15 and 15a intersect each other at acute or obtuse angles, other than the 90° angle shown.

The length of the sides of these geometric figures in the grid netting may vary relatively widely depending upon the needs and the requirements of the particular situation. Sides as small as about 1/12 inch or about 1/8 inch are of use, although sides having a length of about 1/5 inch to about 1/4 inch are more commonly employed.

Longer sides of up to about 1/2 inch or about 3/4 inch are utilizable, and even longer lengths are useful in special situations.

The grid netting is usually described in terms of its mesh size. For example, a 3 x 5 grid netting means that there are three monofilaments per inch in one direction and five monofilaments per inch in the other direction. Many other mesh sizes are of use. Such include: 4 x 9; 4 x 4; 7 x 9; etc.

The physical nature and the chemical composition of the grid netting 14, however, must be such that is possesses a sufficient degree of potential thermoplasticity and potential shrinkability at the time it is inserted between the layers of fibrous materials.

Another important feature of the grid netting 14 is the fact that the thicknesses of the intersections of the filaments 15 and 15a can be made the same as the thicknesses of the interstitial filaments between the intersections whereby there are no high spots or low spots as is present in a conventionally woven gauze or scrim in which the intersections of the warp and filling are considerably thicker than the individual thicknesses of the interstitial warp and filling between the intersections. This flatness feature is, of course, a great advantage in the manufacture of the laparotomy sponge in that there is more intimate and more complete contact of all parts of the grid netting with the adjacent fibrous webs. Additionally, there is a complete absence of high spots or

"bumps" in the laparotomy sponge which is advantageous during its subsequent use in a medical or surgical procedure or operation.

The weight of the plastic grid netting may vary relatively widely depending upon the needs and requirements of the particular situation. Weights as low as about 15 grains per square yard up to about 150 or more grains per square yard are found satisfactory. Within the more commercial aspects of the present invention, however, a range of from about 30 grains per square yard to about 80 grains per square yard is deemed desirable.

The physical nature and the chemical composition of the grid netting 14, however, is such that it possesses a sufficient degree of potential residual shrinkage at the time it is inserted between the layers of fibrous materials. Potential shrinkages of only about 3% are of use in the application of the present invention but larger potential shrinkages are preferred in the range of from about 5% to about 10% or 15%. Larger potential shrinkages up to 20% or 25% or even larger are useful in special applications.

The degree of residual or potential shrinkage which exists in the grid netting is controlled to a large extent by the particular processing and manufacturing techniques used in the original formation and pre-treatment of the grid netting itself. This is a very important factor. For example, the greater the degree of elongation, stretching, and drawing of the polymeric material during its original manufacture and the resulting greater degree

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polymeric grid materials which are more difficult to adhesively bond to the fibrous layers.

The rearranged laminated structure 33' is then passed through conventional adhesive-applying or bonding apparatus 34 wherein a bonding agent is applied. The specific form of bonding method and apparatus is not critical and basically any well known form of rotatable print rolls which are suitably engraved or embossed as to pick up the proper amount of bonding agent from a trough or tank and deposit the same in the desired pattern on the laminated fabric is suitable.

Other forms of bonding, using other forms of coating and impregnating methods and apparatus, are also possible. Spraying, padding, dipping, and other forms of saturation or overall bonding are of value.

The binder used in adhering the plurality of webs and the grid netting together may be selected from a large group of such binders known to industry. It is necessary, however, that a binder be used which can satisfactorily adhere to and bond the different types of fibers together or at least mechanically interlock the fibers together. Representative of the binders available for such a purpose are : regenerated cellulose; vinyl resins such as plasticized or unplasticized polyvinyl acetate, polyvinyl chloride, polyvinyl alcohol, etc., either as homopolymers or copolymers; acrylic resins such as ethyl acrylate, methyl methacrylate, butyl acrylate, butyl methacrylate, etc.; butadiene resins such as butadiene-acrylonitrile,

butadiene-styrene, etc.; other synthetic rubbers; natural rubber; urea resins such as urea-formaldehyde, cyclic urea-formaldehyde, etc.; aldehyde resins such as melamine-formaldehyde, phenol-formaldehyde, resorcinol-formaldehyde, etc.; epoxy resins; cellulose derivatives such as carboxymethyl cellulose; hydroxyethyl cellulose, etc.; starches; gums; casein; etc.

These binders may be added, as desired, in the form of emulsions, solutions, dispersions, plastisols, powders, etc. Autogenic bonding, preferably by heat and/or pressure and/or solvents, may also be used when thermoplastic fibers are present.

The percent add-on of such binder materials may be varied within relatively wide limits, depending to a large extent upon the specific binder employed and upon the type, weight and thickness of the fibrous web. For some binders, as low as about 1% by weight up to about 12% by weight, based on the weight of the dry webs being bonded, has been found satisfactory. For other binders, as high as from about 15% to about 50% by weight has been found preferable. Within the more commercial aspects of the present invention, however, from about 2% to about 35% by weight based on the weight of the dry webs being bonded has been found desirable.

The particular size, shape and configuration of the binder pattern used falls within the scope and range of binder areas previously used in the prior art. Examples of some of these binder patterns may be found in the

abovementioned U.S. Patents 2,705,687 and 2,705,688 or in U.S. Patent 2,880,111. Specific examples of binder areas, binder shapes and sizes, and interbinder spaces are noted in said patents.

The rearranged laminated structure 33" with the applied binder is then forwarded to a suitable heating device such as a heated oven 35 which is maintained at an elevated temperature in order to dry and, if necessary, cure the applied binder.

The temperature, pressure and duration of time of the heating, drying and curing are, of course, interdependent. Higher temperatures permit the use of shorter exposure times, and lower temperatures require the use of longer exposure times. Temperatures in the range of from about 212°F. to about 325°F. are normally used with exposure times of from about 20 seconds to about 30 minutes.

The combined mechanical and adhesive bonding between the fibrous webs and the plastic grid netting thus forms a superior bond to that obtained by mechanical bonding alone or by adhesive bonding alone.

The bonded nonwoven fabric 10' is then forwarded to suitable wind-up rolls 37 to be used as supply rolls for the next procedure.

THE MANUFACTURE OF THE ABSORBENT PRODUCT

The assembling of a plurality of bonded nonwoven fabrics 10' into a laminated structure is shown in Figure 4. In this Figure, there is shown a plurality of supply rolls

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37 which supply four layers of reinforced nonwoven fabrics 10' into the nip of rotatable pressure-applying rolls 38 and 40 which serve to press the laminated structure 39 into the desired relationship.

The laminate 39 of four reinforced nonwoven fabrics 10' is then forwarded by any desired means and passes under a heated cutting and heat-sealing platen 42 which reciprocates vertically, as shown, and serves to heat-seal the laminate 39 into a bonded, self-sustaining absorbent product.

The temperature, pressure, and duration of time of the heat-sealing are, of course, interdependent. Higher temperatures permit the use of shorter exposure times and lower pressures, and lower temperatures require the use of longer exposure times and higher pressures. Temperatures in the range of from about 225°F. to about 400°F. or 600°F., for periods of a part of a second, say 0.2 second, or a few seconds, say 1 or 2, up to 5 or 10 seconds, are possible. The pressures employed are generally in the range of from about 30 pounds per square inch (gauge) to about 100 pounds per square inch (gauge) and preferably from about 40 pounds per square inch to about 80 pounds per square inch (gauge).

As will be described in greater detail hereinafter, the heat sealing takes place along the peripheral edges of the laminate 39 as well as internally thereof, as desired or required. Pressure is exerted by the heated platen 42 which presses the laminate 39 against a station-

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ary base or anvil 44. At the rearward or trailing edge of the platen 42 and anvil 44, a conventional cutting device (not shown) is used to cut the endless length of laminate 39 into shorter lengths 46 which are forwarded by conveying means such as a conveyor belt 48 to an assembly zone 50 where tapes or loops 52 are applied, as desired or required.

Although four reinforced nonwoven fabrics are used to illustrate the invention, it is to be appreciated that other combinations and other numbers of reinforced non-woven fabrics may be used.

In Figure 5, there is shown a variation of the method and apparatus illustrated in Figure 4. In Figure 5, supply rolls 57 forward reinforced nonwoven fabrics through the nips of rotatable pressure-applying rolls 58, 60 to form a laminate 59. This laminate is then passed through the nip of heated rotatable sealing and cutting rolls 62 and 64 which serve to press together and heat the laminate at its peripheral edges and internally thereof, as desired or required. Conventional cutting means (not shown) are used to sever the endless lengths of the laminate 59 into short lengths 66 which are forwarded by conveying means such as a conveyor belt 68 to an assembly zone 70 where tapes or loops 72 are attached, as desired or required.

Figures 6 and 7 illustrate one typical form of bonding used to bond the laminate 39 at its peripheral edges 51 and internally thereof. Figure 6 shows one manner of attaching the tapes or loops 52 to the main

body of the laparotomy sponge.

Figures 8 and 9 illustrate another typical form of bonding used to bond the laminate 59 at its peripheral edges 71 and internally thereof. Figure 8 shows another manner of attaching the tapes or loops 72 to the main body of the laparotomy sponge.

It is to be appreciated that many other forms of bonding and bonding designs internally of the peripheral edges may be employed. For example, instead of using diagonals which form an "X" as in Figure 8, lines parallel to the peripheral edges may be used to form a "+", dividing the sponge into four substantially equal quadrants. Instead of using rectangles as in Figure 6, other geometric figures may be used. Such other figures include squares, ellipses, ovals, circles, annuli, polygons, hexagons, etc.

The invention will be further described by reference to the following Examples wherein there are disclosed preferred embodiments of the present invention. However, it is to be appreciated that such Examples are illustrative and not limitative of the broader aspects of the inventive concept.

EXAMPLE I

Four laparotomy sponges having dimensions of about 14 inches x 14 inches (after sterilization) are prepared to the following specifications:

(1) Four plies of bonded rearranged "KEYBAK" non-woven fabric comprising rayon fibers, 1-1/2 denier and 1-9/16 inches staple length with each ply comprising two

fibrous webs weighing about 172 grains per square yard to provide a total weight (4 plies) of 1376 grains per square yard. No reinforcement is used.

(2) Four plies of reinforced bonded rearranged "KEYBAK" nonwoven fabric with each ply comprising a polypropylene reinforcing reticulate grid 3 x 5 netting weighing 45 grains per square yard covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, each web weighing 185 grains per square yard to provide a weight of 414 grains per square yard per ply or a total weight (4 plies) of 1656 grains per square yard.

(3) Four plies of reinforced bonded rearranged "KEYBAK" nonwoven fabric with each ply comprising a 6 x 4 rayon leno weave weighing 71 grains per square yard covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, each web weighing 185 grains to provide a weight of 440 grains per square yard per ply or a total weight of 1760 grains per square yard.

(4) Four plies of reinforced bonded rearranged "KEYBAK" nonwoven fabric with each ply comprising a 6 x 6 rayon leno weave weighing 106 grains per square yard covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, each web weighing 185 grains per square yard to provide a weight of 476 grains per square yard per ply or a total weight of 1904 grains per square yard.

All the fibrous webs are bonded with a formulated Rohm & Haas HA-8, which is essentially a self cross-linkable ethyl acrylate copolymer binder. A wavy line print pattern is used with four 0.024 inch wide lines per inch. There are 165 apertures formed per square inch during the fluid-rearranging process. The general procedures of Figure 3 are followed, when applicable to the type of sample being made.

The four samples are formed into laparotomy sponges in accordance with the method illustrated in Figure 4. They are sterilized to shrink and ripple to varying degrees of surface interest, softness, bulk and rippled effect as a result of such sterilization.

Sample 2 containing the thermoplastic grid netting bonds autogenously at its peripheral edges and internally thereof as illustrated in Figures 6 and 7. The thermoplastic grid netting softens and causes bonding. Samples 1, 3 and 4, not containing any thermoplastic grid netting do not bond autogenously and are stitched and sewn together at their peripheral edges and internally thereof.

Three samples of each are prepared; all three are evaluated and the average evaluation is shown below:

	Nonwoven Fabric Control	Nonwoven Fabric w/grid Netting	Nonwoven Fabric w/6 x 4 Leno	Nonwoven Fabric w/6 x 6 Leno
Grain weight per sq. yd. per ply	344	414	440	476
Total grain weight per 4 plies	1376	1656	1760	1904

*Tensile Strength M/D Dry (lbs)	18.6	21.3	29.4	28.6
*Tensile Strength M/D Wet (lbs)	11.8	16.6	15.5	16.6
*Tensile Strength C/D Dry (lbs)	0.9	7.9	5.9	10.2
*Tensile Strength C/D Wet (lbs)	0.8	7.5	3.9	6.4
Bulk (1 ply) lbs.	.012	.014	.014	.017
Bulk (4 ply) lbs.	.038	.053	.049	.057
Softness 4 x 4	10.2	16.2	34.5	31.5

*4-ply strips, 1-inch width

(1) Sample 1 (4 plies of bonded nonwoven fabric without any reinforcement) is unsatisfactory. The cross tensile strengths are too low; and the wet and dry bulk and resilience are too low.

(2) Sample 2 (4 plies of bonded nonwoven fabric with grid netting reinforcement) is satisfactory. Tensile strengths are excellent; wet and dry bulk and resilience are good; and softness is excellent. The puckered, rippled effect creates desirable softness, bulk, and surface interest.

(3) Sample 3 (4 plies of bonded nonwoven fabric with 6 x 4 leno weave reinforcement) is unsatisfactory. Softness is too low; wet and dry resilience are too low; and fabric is too harsh and has an unsatisfactory hand.

(4) Sample 4 (4 plies of bonded nonwoven fabric with 6 x 6 leno weave reinforcement) is unsatisfactory. Softness is too low; wet and dry resilience are too low; and fabric is too harsh and has an unsatisfactory hand.

EXAMPLE II

The procedures of Example I are followed substantially as set forth therein with the exception that the HA-8 ethyl acrylate polymer binder is replaced with a viscose regenerated cellulose binder. All other conditions remain the same.

The test results are comparable to those obtained in Example I. Only the seond sample (4 plies of bonded nonwoven fabric with a grid netting reinforcement) is completely satisfactory.

EXAMPLE III

The procedures of Example I are followed substantially as set forth therein with the exception that the HA-8 ethyl acrylate polymer binder is replaced by a Goodrich 2600X120 self cross-linkable acrylic copolymer binder. All other conditions remain the same.

The test results are comparable to those obtained in Example I. Only the second sample (4 plies of bonded nonwoven fabric with a grid netting reinforcement) is completely satisfactory.

EXAMPLE IV

The procedures of Example I are followed substantially as set forth therein with the exception that there are (a) 95 apertures, (b) 225 apertures, and (c) 144 apertures formed per square inch rather than 165 apertures during the fluid-rearranging process. The 144 and 225 apertured designs are square designs; that is, the apertures are aligned in rows in two directions in checkerboard fashion.

The 95 and 165 apertured designs have the apertures staggered or nesting into each other in adjacent rows.

The test results are comparable to those obtained in Example I. Only the second sample (4 plies of bonded non-woven fabric with a grid netting reinforcement) is completely satisfactory.

EXAMPLE V

The procedures of Example I are followed substantially as set forth therein with the exception that in Sample 2, the 3 x 5 polypropylene reinforcing reticulate grid netting weighs: (a) 39 grains per square yard; (b) 47 grains per square yard; and (c) 55 grains per square yard rather than 45 grains per square yard.

The results are generally comparable to those obtained for Sample 2 in Example I, with the additional observation that autogenic bonding is easier and more effective with larger amounts of the thermoplastic polypropylene grid netting.

EXAMPLE VI

The procedures of Example I are followed substantially as set forth therein with the exception that in Sample 2 the reinforcing reticulate grid netting is (a) predominantly isotactic polypropylene and (b) high density polyethylene having a density between 0.95 and 0.96 grams per cubic centimeter.

The results are generally comparable to those obtained for Sample 2 in Example I. Both products are satisfactory for use as laparotomy sponges.

EXAMPLE VII

Six laparotomy sponges are prepared to the following specifications:

(1) Four plies of bonded rearranged "KEYBAK" nonwoven fabric comprising rayon fibers, 1-1/2 denier and 1-9/16 inches staple length; each ply comprising two fibrous webs weighing about 172 grains per square yard to provide a total weight (4 plies) of 1376 grains per square yard.

(2) Four plies of reinforced bonded rearranged "KEYBAK" nonwoven fabric with each ply comprising a polypropylene reinforcing reticulate 3 x 5 grid netting weighing 45 grains per square yard covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, each web weighing 185 grains per square yard to provide a weight of 414 grains per square yard per ply or a total weight (4 plies) of 1656 grains per square yard.

(3) Four plies of reinforced bonded rearranged "KEYBAK" nonwoven fabric with each ply comprising a 6 x 4 rayon leno weave weighing 71 grains per square yard covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, each web weighing 185 grains to provide a weight of 440 grains per square yard per ply or a total weight of 1760 grains per square yard.

(4) Four plies of reinforced bonded rearranged "KEYBAK" nonwoven fabric with each ply comprising a 6 x 6 rayon leno weave weighing 106 grains per square yard

covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, each web weighing 185 grains to provide a weight of 476 grains per square yard per ply or a total weight of 1904 grains per square yard.

(5) Four plies of bonded "MASSLINN" nonwoven fabric which are not rearranged and not reinforced are made from rayon fibers 1-1/2 denier and 1-9/16 inches staple length; each ply comprises two fibrous webs each weighing about 172 grains per square yard to provide a total weight (4 plies) of 1376 grains per square yard.

(6) Four plies of U.S.P. 28 x 24 cotton mesh gauze.

All the fibrous webs are bonded with a formulated Rohm & Haas HA-8, which is essentially a self cross-linkable ethyl acrylate copolymer binder. A wavy line print pattern is used with four 0.024 inch wide lines per inch. There are 165 apertures formed per square inch during the fluid-rearranging process. The general procedures of Figure 3 are followed, when applicable to the type of sample being made.

The six samples are formed into laparotomy sponges in accordance with the method illustrated in Figure 4. They are sterilized by heating. Only Sample 2 shrinks and puckers to a desirable surface interest and appearance, and possesses excellent bulk and a pleasing rippled effect as a result of such sterilization and the differential shrinking effect.

Sample 2 containing the thermoplastic grid netting

bonds autogenously at its peripheral edges and internally thereof, as illustrated in Figures 6 and 7. Samples 1 and 3-6 which do not contain a thermoplastic grid netting do not bond autogenously and are stitched and sewn together.

36" x 36" squares are cut from each sample and are autoclaved at 250°F. for thirty minutes. Each sample is then soaked in distilled water for thirty seconds and allowed to absorb 150 ml. Excess water absorption is removed by squeezing. Each sample is then placed in a 1000 ml. tall Pyrex beaker (4" internal diameter) in a randomly-balled manner. A plastic beaker (3-1/2" external diameter) is placed on top on the randomly-balled sample and various weights are added, causing the sample to compress. The degree of compression is observed. All weights are then removed and the amount of spring-back or resilience is observed. The results are as follows:

	631.5 grams	1282.5 grams	1941.5 grams	Amount of Spring-back
"KEYBAK nonwoven fabric	730	800	820	30
Nonwoven fabric with grid netting (3 samples)	390 450 450	600 630 650	670 700 700	170 100 100
Nonwoven fabric with 6 x 4 leno	650	740	800	40
Nonwoven fabric with 6 x 6 leno	600	750	770	60
"MASSLINN" non-woven fabric	670	760	820	50
28 x 24 cotton gauze	750	800	820	40

The larger the number, the greater is the compaction

Values of 800 and 820 reveal substantially no resistance to the application of compressive force. Such values are very unsatisfactory. Lower numbers reveal greater resistance to the application of compressive force. These are desirable.

Sample 2 containing the reinforcing thermoplastic grid netting passes the wet bulk compression test and is considered satisfactory. The amount of "spring-back" or "bounce-back" is sufficient and the sample is deemed to possess sufficient resilience.

All other samples fail the wet bulk compression test and are considered unsatisfactory. The amounts of "spring-back" or "bounce-back" are insufficient and all other samples are deemed to possess insufficient resilience.

EXAMPLE VIII

The procedures of Example VII are followed substantially as set forth therein with the exception that (0.9%) saline solution, containing sodium chloride in the proportion of 9 to 1000, is substituted for the distilled water.

The results are comparable to those obtained in Example VII. Sample 2 containing the thermoplastic grid netting passes the wet bulk compression test and the resilience test. All other samples fail these tests.

EXAMPLE IX

Six laparotomy sponges are prepared to the following specifications:

(1) Four plies of bonded rearranged "KEYBAK" nonwoven

fabric comprising rayon fibers, 1-1/2 denier and 1-9/16 inches staple length; each ply comprising two fibrous webs weighing about 172 grains per square yard to provide a total weight (4 plies) of 1376 grains per square yard.

(2) Four plies of reinforced bonded rearranged "KEYBAK" nonwoven fabric; polypropylene reinforcing reticulate 3 x 5 grid netting weighing 45 grains per square yard covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, each web weighing 185 grains per square yard to provide a weight of 414 grains per square yard per ply or a total weight (4 plies) of 1656 grains per square yard.

(3) Four plies of reinforced bonded rearranged "KEYBAK" nonwoven fabric; polypropylene reinforcing reticulate 4 x 9 grid netting weighing 55 grains per square yard covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, each web weighing 185 grains to provide a weight of 425 grains per square yard per ply or a total weight (4 plies) of 1700 grains per square yard.

(4) Four plies of reinforced nonwoven fabric; 6 x 4 rayon leno weave weighing 71 grains per square yard covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, each web weighing 185 grains per square yard to provide a weight of 440 grains per square yard per ply or a total weight of 1760 grains per square yard.

(5) Four plies of reinforced bonded rearranged

"KEYBAK" nonwoven fabric; 6 x 6 rayon leno weave weighing 106 grains per square yard covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, each web weighing 185 grains to provide a weight of 476 grains per square yard per ply or a total weight of 1904 grains per aquare yard.

(6) Four plies of U.S.P. 28 x 24 cotton gauze fabric.

The linting properties and characteristics of these samples are determined as follows: 10 samples of each sponge are steam sterilized at 250°F. for 30 minutes and then conditioned at 65% Relative Humidity and 70°F. for at least four hours. The samples are then weighed. The samples are then immersed and dipped five times in 1000 ml. saline solutions in a 1500 ml. beaker. The samples are squeezed once to remove all free running water which is returned to the 1500 ml. beaker. The wet samples are then placed on a black filter paper on a Büchner funnel and the remainder of the collected 1000 ml. saline solution filtered through the sample on the black filter paper. The samples are then washed with distilled water. The lint is then collected and weighed and averages for the ten samples are calculated. The results are as follows:

		% Linting
(1)	"KEYBAK" nonwoven fabric	0.016%
(2)	Nonwoven fabric with 3 x 5 grid netting (3 samples)	0.005% 0.005% 0.005%
(3)	Nonwoven fabric with 4 x 9 grid netting	0.005%
(4)	Nonwoven fabric with 6 x 4 leno	0.011%
(5)	Nonwoven fabric with 6 x 6 leno	0.010%
(6)	28 x 24 cotton gauze	0.011%

Samples 2 and 3 containing the reinforcing thermoplastic grid netting pass the linting test and are considered satisfactory. Samples 1 and 4-6 do not pass the linting test described above and are considered relatively unsatisfactory.

EXAMPLE X

A reinforced bonded rearranged "KEYBAK" nonwoven fabric is prepared by placing a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length weighing 750 grains per square yard on each side of a polypropylene reinforcing reticulate 4 x 9 grid netting weighing 100 grains per square yard. Rearrangement forms fabric openings and fiber bundles, whereby many individual fibers are intertwined and wrapped around the grid netting. Adhesive bonding with HA-8, a self cross-linkable ethyl acrylate copolymer, bonds the nonwoven fabric. Autogenic heat sealing at the peripheral edges and internally thereof is rendered more difficult due to the heavier weight of the fibrous webs. However, the heavier weight of the polypropylene grid netting helps in the autogenic bonding. The resulting product, however, is relatively stiff and has poor drape and hand. It is not soft. Upon sterilization, the reinforced nonwoven fabric shrinks as do all such fabrics but the instant fabric becomes stiff and boardy. It is not suitable for use as a surgical sponge or pad.

EXAMPLE XI

Four samples as described in particularity in

Example I are prepared and their bulk or thicknesses measured both before and after undergoing sterilization procedures in steam at 250°F. for 30 minutes. The results are as follows:

		Thickness Before	Thickness After	Percent Change
(1)	"KEYBAK" nonwoven fabric	0.009"	0.009"	0.0%
(2)	"KEYBAK" nonwoven fabric with grid netting (3 samples)	0.018" 0.020" 0.014"	0.020" 0.023" 0.018"	+11.1% +15.0% +28.6%
(3)	"KEYBAK" nonwoven fabric with 6 x 4 leno	0.013"	0.014"	+ 0.77%
(4)	"KEYBAK" nonwoven fabric with 6 x 6 leno	0.017"	0.016"	- 0.59%

Sample 2 shrinks as noted and creates a very desirable rippling and puckering effect, thus enhancing the surface interest of the product and increasing the softness and bulk thereof. These products are considered satisfactory for use as laporatomy sponges.

Samples 1, 3 and 4 do not shrink materially and remain relatively flat without any enhancement of the surface interest, softness or bulk. These products are not considered satisfactory for use as laparotomy sponges.

EXAMPLE XII

A laporatomy sponge is formed of six plies of reinforced, bonded, rearranged "KEYBAK" nonwoven fabric, each ply comprising a central layer of polypropylene reinforcing reticulate grid 3 x 5 netting weighing 40 grains per square yard, covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, weighing 140 grains, for a total weight (6 plies)

of 1920 grains per square yard. The laporatomy sponge is found satisfactory in use.

EXAMPLE XIII

A laporatomy sponge is formed of three plies of reinforced, bonded, rearranged "KEYBAK" nonwoven fabric, each ply comprising a central layer of polypropylene reinforcing reticulate grid 3 x 5 netting weighing 55 grains per square yard, covered on each side by a fibrous web of rayon fibers 1-1/2 denier and 1-9/16 inches staple length, weighing 220 grains, for a total weight (3 plies) of 1485 grains per square yard. The laporatomy sponge is found satisfactory in use.

Although the invention has been described in particularity and detail by reference to the preceding specific Examples, such is for the purpose of illustrating the invention and is not to be construed as limiting it, except as defined by the appended claims.

The following names as used herein are Registered Trade Marks: Key-back, Arlon, Acrilan, Creslan, Dynel, Verel, Kodel

The claims defining the invention are as follows:-

1. A bonded, self-sustaining, single-use, disposable absorbent product having excellent softness and excellent strength, bulk, resilience and resistance to surface abrasion and linting when wet, comprising a plurality of layers of reinforced nonwoven textile fabrics, each of said layers comprising a synthetic polymeric thermoplastic reinforcing reticulate grid netting covered on each side by at least one layer of a nonwoven textile fabric of overlapping, intersecting fibers mechanically intertwined and wrapped around the individual elements of said grid netting; and said plurality of layers of reinforced nonwoven textile fabrics being secured together at their peripheral edges to form a bonded, self-sustaining, single-use, disposable absorbent product having excellent softness and excellent strength, bulk, resilience and resistance to surface abrasion and linting when wet.

2. An absorbent product as defined in Claim 1 wherein the synthetic polymeric thermoplastic reinforcing grid netting comprises intersecting filaments which are integral at their intersections.

3. An absorbent product as defined in Claim ~~1~~ 2 wherein the thickness of the intersection of the filaments is substantially equal to the thickness of the interstitial filaments between the intersections.

4. An absorbent product as defined in Claim 1 wherein the synthetic polymeric thermoplastic grid netting is polypropylene.

5. A bonded, self-sustaining, single-use, disposable surgical sponge having excellent softness and excellent strength, bulk, resilience and resistance to abrasion and linting when wet, comprising a plurality of layers of reinforced nonwoven textile fabrics, each of said layers comprising a synthetic polymeric thermoplastic reinforcing reticulate grid netting covered on each side by at least one layer of nonwoven textile fabric of overlapping, intersecting fibers mechanically intertwined around the individual elements of said grid netting; and said plurality of layers of reinforced nonwoven textile fabrics being secured together at their peripheral edges to form a bonded, self-sustaining, single-use, disposable absorbent product having excellent softness and excellent strength, bulk, resilience and resistance to surface abrasion and linting when wet.

6. A bonded, self-sustaining, single-use disposable laparotomy sponge having excellent softness and excellent strength, bulk, resilience and resistance to surface abrasion and linting when wet, comprising a plurality of layers of reinforced nonwoven textile fabrics, each of said layers comprising a synthetic polymeric thermoplastic reinforcing reticulate grid netting covered on each side by at least one layer of a nonwoven textile fabric of overlapping, intersecting fibers mechanically intertwined around the individual elements of said grid netting; and said plurality of layers of reinforced nonwoven textile fabrics being secured together at their peripheral edges and internally thereof to form a bonded, self-sustaining,

single-use, disposable absorbent product having excellent softness and excellent strength, bulk, resilience and resistance to surface abrasion and linting when wet.

7. A laparotomy sponge as defined in Claim 6 wherein there are four layers of reinforced nonwoven textile fabrics.

8. A method of making a bonded, self-sustaining, single-use, disposable absorbent product having excellent softness and excellent strength, bulk, resilience and resistance to surface abrasion and linting when wet, comprising: forming a laminate of a plurality of layers of reinforced nonwoven textile fabrics, each of said layers comprising a synthetic polymeric thermoplastic reinforcing reticulate grid netting covered on each side by at least one layer of a nonwoven textile fabric of overlapping, intersecting fibers mechanically intertwined around the individual elements of said grid netting; and securing said plurality of layers of reinforced nonwoven textile fabrics together at their peripheral edges to form a bonded, self-sustaining, single-use, disposable absorbent product having excellent softness and excellent strength, bulk, resilience and resistance to abrasion and linting when wet.

9. A method as defined in Claim 8 wherein the plurality of layers of reinforced nonwoven fabrics are autogenously bonded together at their peripheral edges.

10. A method of making a bonded, self-sustaining, single-use disposable absorbent product having excellent softness

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and excellent strength, bulk, resilience and resistance to surface abrasion and linting when wet, comprising: forming a synthetic polymeric thermoplastic reinforcing grid netting defining a pattern of open area; placing at least one layer of fibrous materials on each side of said grid netting; adhering said layer of fibrous materials to said grid netting; forming a laminate of a plurality of layers of said grid netting and fibrous materials adhered thereto; and securing said plurality of layers together at their peripheral edges to form a bonded, self-sustaining, single-use, disposable absorbent product having excellent softness and excellent strength, bulk, resilience and resistance to surface abrasion and linting when wet.

Dated this sixteenth day of November , 1971.

JOHNSON & JOHNSON
By their Patent Attorney:

of GRIFFITH, HASSEL & FRAZER.

J.P.

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FIG.1

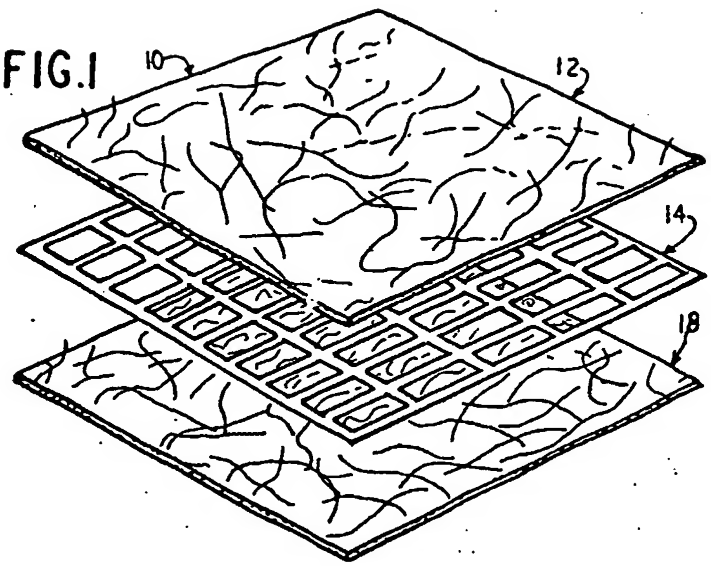
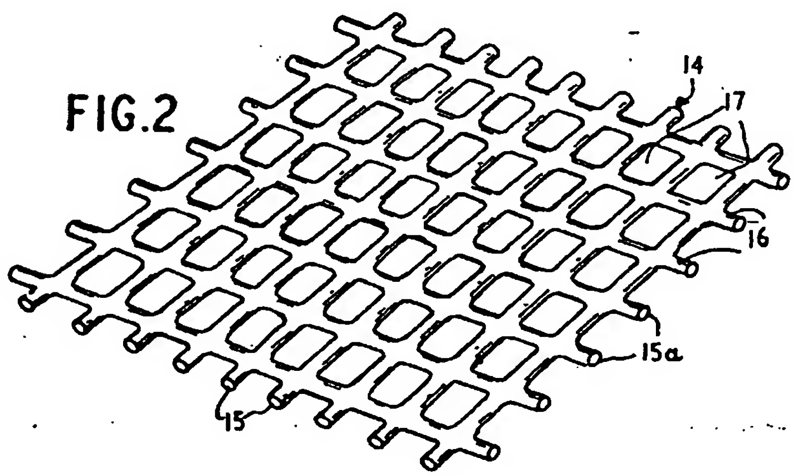


FIG.2



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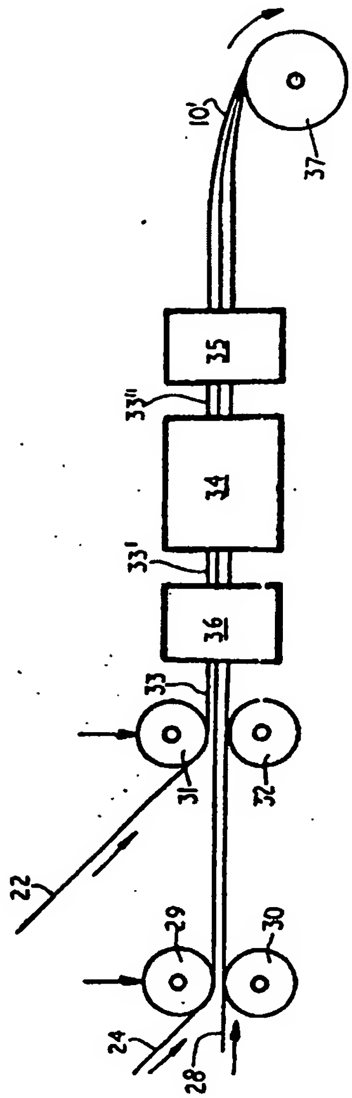

FIG.3

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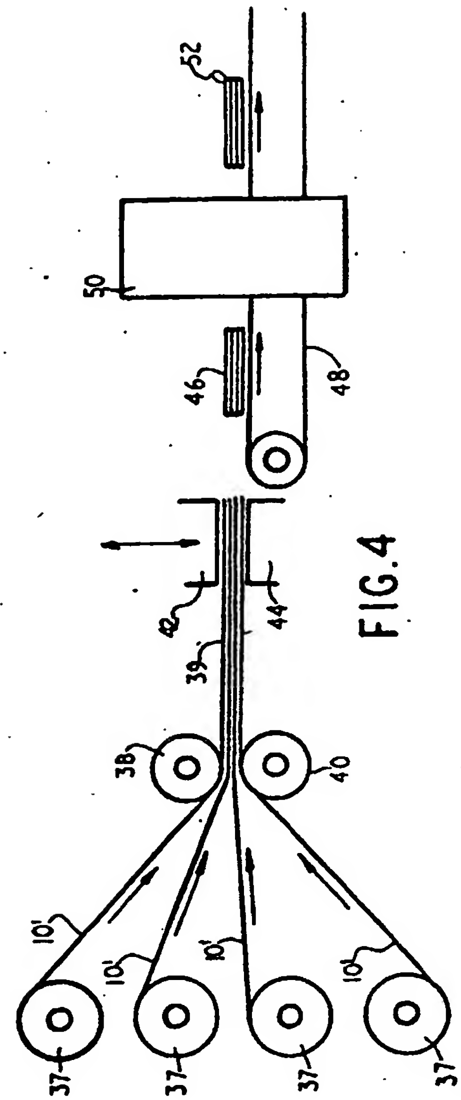
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FIG.4

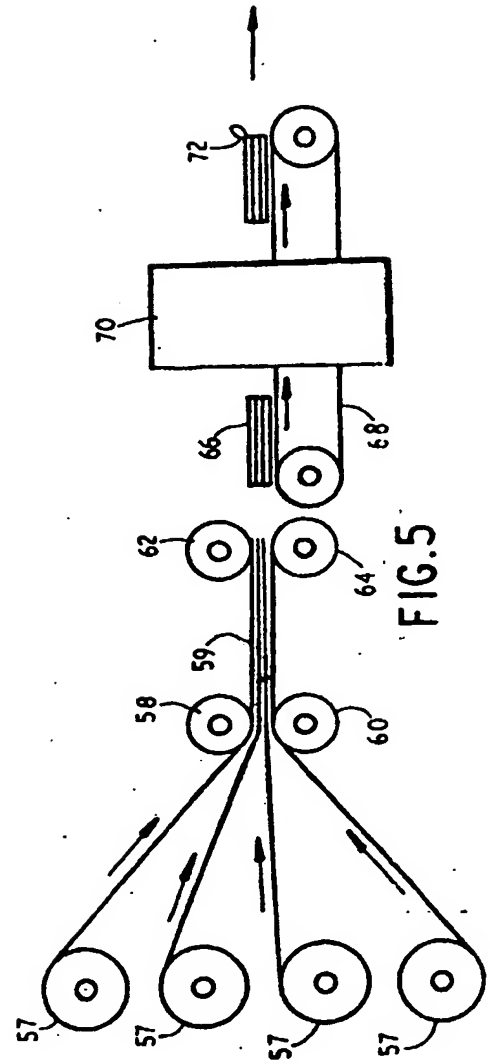
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FIG.5

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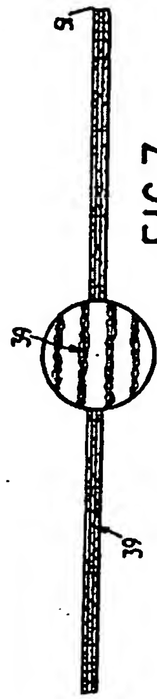

FIG.7

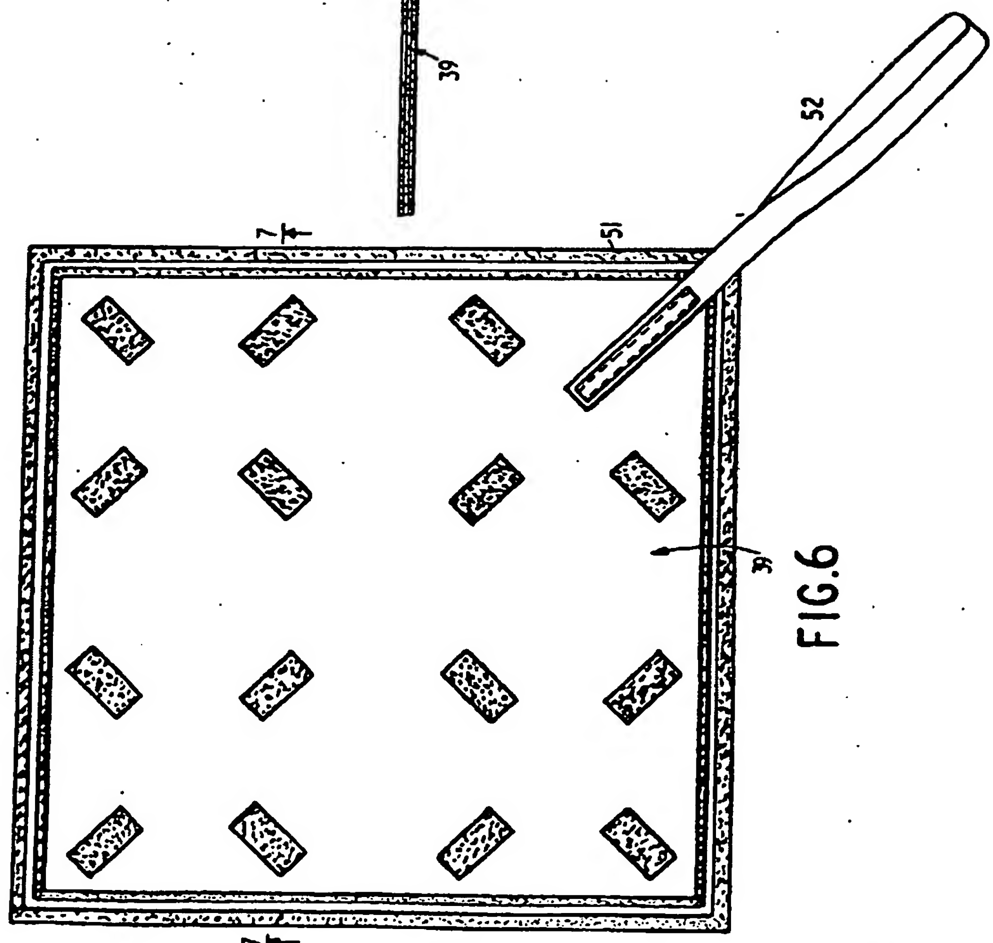

FIG.6

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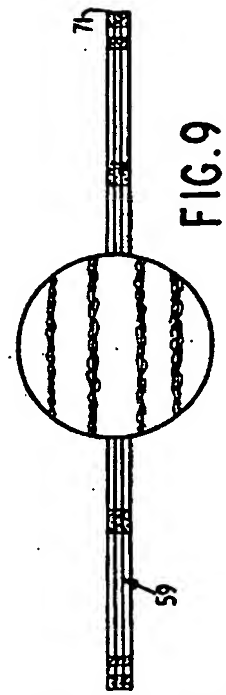

FIG.9

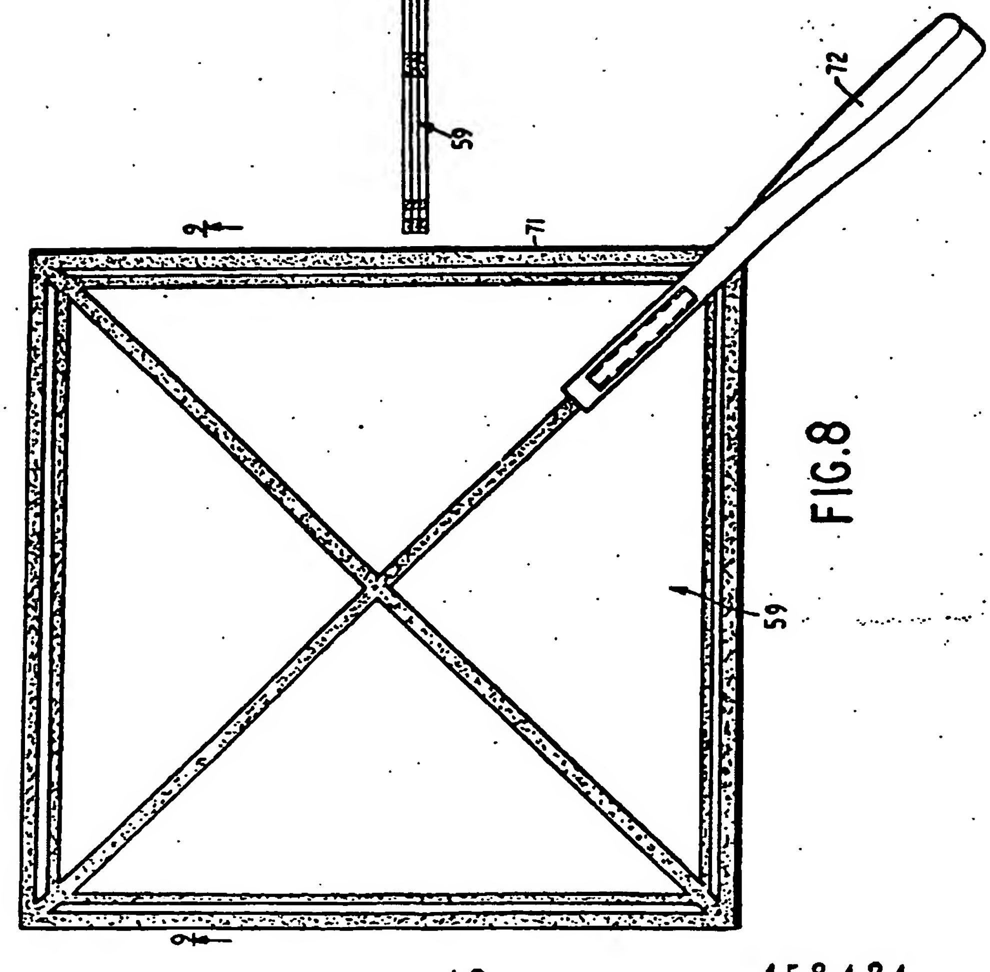

FIG.8

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